Pseudoscience: A skeleton in osteopathy's closet?

Oliver P. Thomson[1] *, Carlo Martini[2, 3]

*corresponding author: oliver.thomson@uco.ac.uk

[1] University College of Osteopathy 275 Borough High Street, London, UK SE1 1JE

[2] Faculty of Philosophy, Vita-Salute San Raffaele University, Milan, Italy

[3] Centre for Philosophy of Social Science, University of Helsinki

Thomson, O. P., & Martini, C. (2024). Pseudoscience: A skeleton in osteopathy's closet?. *International Journal of Osteopathic Medicine*, 100716. https://doi.org/10.1016/j.ijosm.2024.100716

Highlights

- Pseudoscience is information presented as scientific, but on closer examination fails to meet such standards or criteria to be considered as science.
- Pseudoscience has harmful effects on individual patient care and society more broadly.
- There are historical, professional and sociological factors which make osteopathy susceptible to pseudoscience and which facilitate the propagation of pseudoscientific claims by osteopaths.
- Pseudoscientific claims made by osteopaths and the incorporation of pseudoscience into osteopathy’s knowledge base, threatens the discipline's claim as a legitimate and credible healthcare profession.
- It is important that osteopaths are aware of pseudoscience and recognise when it might be presented as scientific knowledge.

Abstract

Pseudoscience has harmful effects on individual patient care, professions and society more broadly. The use of pseudoscience and spread of misinformation by a healthcare discipline raises questions as to their legitimacy and ethical standing as a profession. Osteopaths and osteopathic physicians are regulated by law as healthcare professionals in many parts of the world with an expectation that relevant aspects of practice are suitably aligned with the scientific paradigm in the form of a commitment to the values of evidence-based practice. This article discusses the system of pseudoscience and considers its historic, present and potential negative impacts on osteopathy and professional progress. We identify possible incentives for some aspects of osteopathy and osteopaths to engage in pseudoscientific thinking and in doing so we discuss osteopathy's susceptibility to pseudoscience and how practitioners may be more aware of and recognise pseudoscientific information and pseudoexpertise.

Keywords: Osteopathic Medicine, Osteopathy; Science, Pseudoscience, Disinformation

Introduction

Osteopaths and osteopathic physicians are regulated by law as healthcare professionals in 13 and 57 countries respectively ("The OIA Global Report: Global Review of Osteopathic Medicine and Osteopathy 2020 – Osteopathic International Alliance" n.d.). Such governance legitimises osteopaths as healthcare *experts* and attempts to recognise and assure the public of osteopaths' skills, knowledge and ethical conduct to enable them to trust their health and well-being in the hands of *professionals*. An effort to align with the scientific paradigm in the form of a commitment to the values of evidence-based practice (EBP) was part of osteopathy's process of professionalisation (Cant and Sharma 1996), and this process continues to take place across the world. In view of the legal and ethical standing of osteopaths, the profession must unite to be critically aware of the nature, quality and credibility of the knowledge which informs its practice, education and communication. It is in this context and in response to an invitation to reflect on osteopathy's future and the potential threats to any possible future (Vogel 2021), that this article discusses the system of pseudoscience and considers its historic, current and potential negative impact on osteopathy and professional progress. We propose the incentives for some osteopath's to engage in pseudoscientific thinking and in doing so we discuss osteopathy's susceptibility to pseudoscience. Finally, we believe that the majority of osteopaths are well-meaning and caring clinicians and are not intentionally looking to deceive by applying, sharing or communicating pseudoscience or misinformation in the context of their clinical practice. As such, an additional aim of this paper is to help raise awareness of the problems and potential harms of pseudoscience for osteopaths, osteopathy and the subsequent care of patients.

Osteopathy and science

The term 'science' has a range of different definitions depending on how it is being used, its context and which aspect of science is being emphasised; but broadly speaking and for the purpose of this paper, 'science' can refer to both a body of knowledge collected through a systematic method and the method itself, which should adhere to relatively well-established epistemological and ethical standards (Chalmers 2013). Upon its conception, osteopathy was claimed to be a science by its founder AT Still (Still 1910), and this claim has been viewed as an attempt to garner credibility for his seemingly novel and alternative healthcare theories and methods at the time (Gevitz 2019). Yet despite this proclamation from over 100 years ago, the role of science in osteopathy continues to be debated (Lucas and Moran 2007; Tyreman 2011; J. Leach 2008). Contemporary philosophical analysis has considered osteopathy (like other healthcare disciplines) to be a *praxis (Tyreman 2008)*, where clinical practice is embodied, relational (Banton and Vogel 2023) and involves utilising knowledge and skills that lie both inside and outside of science, for example tacit, personal, propositional, professional craft, moral and aesthetic forms of knowledge (For a more complete discussion see (Higgs, Richardson, and Dahlgren 2004)).

Science and osteopathy intersect in several different ways and in a variety of contexts. This interaction occurs clinically, epistemically (i.e. in relation to knowledge) and educationally and are discussed in turn. Clinically when working with patients, osteopaths can be said to think in scientific ways, and their clinical reasoning has some similarities to the scientific method. For example, the deliberate generation of hypotheses (differential diagnoses) (Grace et al. 2016), the systematic testing of those hypotheses through focused clinical examination/data collection (Roots, Niven, and Moran 2016), the assessment of probability and risk factors for adverse events of treatment (Vaughan et al. 2016) and the reliance on inductive, deductive (Thomson, Petty, and Moore 2014b) and abductive reasoning (Martini 2023a).

From a knowledge or epistemic perspective, osteopaths utilise scientific knowledge (amongst other forms of knowledge such as those outlined earlier) and incorporate this into their clinical decision-making (Thomson, Petty, and Moore 2014a; Grace et al. 2016). For example, utilising scientific knowledge systematically derived from research to inform treatment decisions with patients (Clifford et al. 2022). Scientific knowledge in the form of anatomy and biomedical information is valued by osteopaths (Blaich, Pather, and Luo 2019), incorporated in their diagnostic reasoning and contributing to the construction of a diagnosis (Thomson, Petty, and Moore 2014b; Grace et al. 2016; Roots, Niven, and Moran 2016).

Finally, in educational contexts scientific values, methods and knowledge (Longino 2020) are promoted to students in university osteopathy courses (Licciardone 2008). In many countries where osteopathy is regulated, educational institutions and universities offer 'Bachelor' or 'Masters' of *Science* as exit qualifications which permit autonomous practice ("The OIA Global Report: Global Review of Osteopathic Medicine and Osteopathy 2020 – Osteopathic International Alliance" n.d.). Research projects (dissertations) are commonly employed assessment methods to measure students' knowledge and skills of the scientific method. Furthermore, the biomedical and psychological sciences are key (some would argue core) components of osteopathic curricula, and involve various assessment methods to develop and test other virtues of the scientific method such as critical thinking/analysis, reflection and scientific reasoning (Vaughan et al. 2012). Taken together, osteopathy and osteopaths declare (both implicitly and explicitly) some degree of scientific status or alignment. There are incentives for osteopathy to appear or claim to be 'scientific' as the label not only describes an approach to healthcare but the term's value-ladenness means that it carries connotative meanings like 'trustworthy', 'reliable', and even 'true' (Laudan 1983).

To be clear, we are not making a case for scientific knowledge to *exclusively* form the basis of an osteopathic epistemology or knowledge-base; we agree with others (Kerry 2017; Steel et al. 2017) that any contemporary scientific research within a person-centred discipline such as osteopathy, should account for real-world complexity - meaning a broad range of methodologies (both qualitative and quantitative) with the associated knowledge/evidence should be combined with patients' values, preference and the clinical judgement and expertise of the osteopath (Greenhalgh et al. 2014). The limitations of research methods which are underpinned by scientific assumptions - such as the randomised control trial (RCT), to accurately capture the outcomes of complex interventions whose effects are often context-dependent are well described (see (Anjum, Copeland, and Rocca 2020)).

However, osteopathy should not resort to pseudoscience in the face of such methodological challenges (which are also faced by many other health professions); but instead adopt new methods to work within the scientific paradigm in order to test and develop new knowledge about its treatments. An example includes novel approaches when designing, conducting sham/placebo control interventions when investigating non-pharmacological treatments using RCTs (Hohenschurz-Schmidt et al. 2023).

The challenge of person-centred care, clinical complexity and the medical uniqueness of individual patients necessitates openness of thought and methods but this must be within the context of coherent and plausible research and practice paradigm(s) (Anjum, Copeland, and Rocca 2020). Much progress has been made by applying scientific methods and values to osteopathy, and there are indeed examples of high quality science-based enquiry and discourse within osteopathy, addressing a range of questions and adopting different methodologies and theoretical positions (for example (Nguyen et al. 2021; Esteves et al. 2022; Licciardone, Kearns, and Minotti 2013). However, where knowledge is claimed to be scientific or purported to be derived from science then we argue that the claimant must respect the well established criteria and methods used to identify scientific knowledge, rather than propagating information which is masquerading as scientific - aka pseudoscience - and is explored in more detail below.

Pseudoscience

The problem of pseudoscience relates closely to the problem of demarcation between what is scientific and what is not, an age-old problem that dates back to the Ancient Greek Philosophers and their distinction between *epistéme* (knowledge) and *doxa* (mere opinion). The more recent demarcationist tradition has sought to define scientific products and practices along unidimensional or multidimensional criteria. For example, Popper's stance on the equivalence between falsifiability of theories and scientificity (Popper 1963), and Pigliucci's characterizations of disciplines along two dimensions: empirical knowledge and theoretical understanding (Pigliucci and Boudry 2013). For Pigliucci, the more a discipline is able to provide us with theoretical understanding of a phenomenon, and to ground this understanding in empirical evidence, the more it is scientific. So, for example, evolutionary biology is highly scientific, while intelligent design is 'bunk', that is, pseudoscience (Pigliucci 2018)

Fasce and Picó (Fasce and Picó 2019) provide a series of criteria that help us identify pseudoscience; Namely, a pseudoscientific claim should be presented as scientific knowledge and meet at least one of the following criteria: "(a) it refers to at least one field or process considered outside the domains of science; (b) it uses procedures that are deficient or do not correspond to the scientific method; and (c) it is not supported by scientific evidence" (pg 268). The criteria are limited in scope, but they help clarify a few key points. A discipline may be generally regarded as pseudoscience, for example, because some of the fundamental assumptions it relies on are false, as shown by relatively established scientific consensus in related fields, or some of the mechanisms it uses to explain phenomena are unrealisable. Yet, this is compatible with the fact that some of the claims its proponents make might not be pseudoscientific. If we could show, for example, that administering a homoeopathic substance is effective at, say, reducing the severity of migraines, this wouldn't make the principles of homoeopathy less pseudoscientific; for instance, the homoeopathic appeal to water memory to provide a causal explanation of why extremely diluted substances in water would still have a causal effect on the

organism. It is worth focusing then on claims, rather than entire disciplines, when discussing pseudoscience, especially in relation to scientific disinformation (Debray 2018).

A therapy might be effective through a placebo mechanism, but if there are factors that weaken the evidence to support the claim, then that can make the claim pseudoscientific (Mukerji and Ernst 2022). These factors are both methodological and social. For example, evidence of insufficient data, or a bias in collecting data, or the use of wrong statistical tests in analysing the data are all methodological red flags. But there are also non-methodological factors that weaken a claim to the scientificity of a statement: absence of peer review, a conflict of interest, or even absence of validation from other independent researchers in the scientific community.

Homoeopathy is frequently held up as an exemplar of pseudoscientific claims and practice (Mukerji and Ernst 2022; Smith 2012). One of the principal physical mechanisms through which homoeopathy is said to work is 'water memory'; a long debunked purported mechanism via which water can retain the memory of substances previously dissolved in it, even after an arbitrary number of dilutions. The theoretical understanding that homoeopathic principles afford us is null, since they are based on mechanisms that are thought to be physically impossible (Grimes 2012). There clearly remains the possibility that some other mechanism might be at work, possibly an unknown one, of which we observe the effects. Homoeopathy, in other words, could be working through a black box. Even so, we should be able to observe its effects in randomised controlled trials. On this front too, however, homoeopathy fails to stand up to the standard of empirical evidence because, apart from placebo or contextual effects, it fails to show efficacy in trials (Ernst 2002).

Pseudoscience is not an 'on-off matter' - it is a matter of degrees. This means that depending on how a claim is arrived at, or how it is justified, can determine how scientifically reliable that claim is. For example, some questions that one might reflect on when considering the scientific reliability of a particular claim include: Is a claim the product of systematic and replicable experience or experimentation? Has the claim gone through peer review? Has the claim elicited agreement within the scientific community? Has the source of the claim been shown to be unreliable, or biassed, for example, by commercial interests? It is only by analysing methodological and social factors can tell us where the balance of evidence lies (Solomon 2015) and how scientific, or conversely, pseudoscientific a claim is. While none of the factors mentioned above (e.g. replicability, peer review, consensus) are by themselves or in combination necessary and sufficient conditions for a claim to be treated as scientific, the combination of such factors gives strength to the characterisation of a claim as scientific or pseudoscientific. It is clear that there are some claims that can easily be proven to be pseudoscientific, and for some we can acquire a high degree of confidence, but for some claims the evaluation might be more complex and leave room for doubt (Mukerji and Ernst 2022). Some may consider 'pseudoscience' to be a pejorative or derogatory term (Laudan 1983), and to that end it most certainly is not value-neutral but carries with it an intended value judgement. Just as 'scientific 'is a value-laden term in so much as the label can add value to a treatment, practice or person, the label 'pseudoscientific' is also value-laden; however, it functions to provide an equalising effect by removing any undeserved benefit of misusing the label of 'scientific' (Martini 2023b).

Finally, the dangers of pseudoscience ought not be confused with the standard process of scientific progress and auto-correction. Science is a highly auto-corrective practice, where old theories and hypotheses become falsified as new data is collected, and a few key theories and hypotheses become more and more accepted by the community as numerous attempts to refute them fail (Lakatos and Musgrave 1970). Much research that we consider scientific can in fact turn out to be false, and, paradoxically, pseudoscientific claims could turn out to be true if investigated with proper scientific methodology. For those reasons it is important to distinguish matters of truth from the matter of the quality of our knowledge (Popper 1963): something in science might turn out to be false, despite our best efforts and best methodology. Despite that, it is neither sensible nor ethical to rely on the poor methodology that permeates pseudoscience even though, while doing that, from time to time we might stumble upon something true.

The harms of pseudoscience

Pseudoscience is harmful in several ways: a) it adds noise to an already noisy information environment where it is often not easy to distinguish between efficacious health practices and harmful ones; b) it generally begets distrust in official science, often by negating well-established scientific knowledge; c) it can lead to direct nefarious outcomes ("Trust in Science and Changing Landscapes of Communication" 2019). Firstly, trust is one of the most important factors for the success of health sciences. Without a healthy relationship of trust with the end users, health interventions are less efficacious (Clark 2002; Kelley et al. 2014). The problem is that the coexistence of science and pseudoscience, paired with laypeople's difficulty to tell the difference between the two, creates a noisy environment in which patients are trying to find good information to help guide their decision-making about their own health care (Swire-Thompson and Lazer 2020). Secondly, pseudoscientific beliefs often run contrary to official scientific knowledge or recommendations, as in the case of online health misinformation in oncology (Teplinsky et al. 2022) . Finally, we can find examples where falling into the disinformation trap can cause very direct harm, as was the case for the many deaths that have been estimated as a cost of AIDS denialism in South Africa (Chigwedere et al. 2008).

Pseudoscience and osteopathy

Pseudoscientific claims and misinformation have been identified in similar disciplines to osteopathy which share similar professional journeys, histories and practices such as chiropractic (G. N. Kawchuk et al. 2023; G. Kawchuk et al. 2020; Axén et al. 2020; Huijbregts 2005). Deserved or not, 'pseudoscience' has been a charge levelled at elements of osteopathy and osteopathic claims by some (Bledsoe 2004; McGrath 2015; Esteves et al. 2020; Ciardo, Sánchez, and Fernández 2023; L'Hermite 2020), including one of the authors of this current paper (Thomson and MacMillan 2023). Importantly, while *some* osteopaths may hold pseudoscientific beliefs or make pseudoscientific claims this does not mean that (all of) *osteopathy is* pseudoscience. Furthermore, the fact that *some* osteopaths make pseudoscientific assertions does not establish that the osteopathic doctrine or the *profession* is pseudoscience. However, there are a range of historical, professional and sociological factors which may prime osteopathy to be vulnerable to pseudoscience and motivate some osteopaths to make and perpetuate pseudoscientific claims - and these are discussed in the following sections below. Firstly, it is encouraging that evidence in

the form of several cross-sectional surveys indicate osteopaths (M. J. Leach et al. 2019; Sundberg et al. 2018; M. J. Leach et al. 2020; Cerritelli et al. 2021; Alvarez et al. 2021; Weber and Rajendran 2018) and osteopathic educators (Vaughan et al. 2019) hold largely positive views of EBP, albeit limited skills to implement EBP including the critical appraisal of evidence. Qualitative research does however suggest that some osteopaths consider scientific and research evidence conflicts with their osteopathic identity and the traditional osteopathic principles (Inman and Thomson 2019; Figg-Latham and Rajendran 2017; Kasiri-Martino and Bright 2016) and these factors may suggest some resistance to EBP and facilitate pseudoscientific claims and endorse pseudoscientific thinking in some corners of the osteopathic profession.

Historically, osteopathy's roots are in complementary and alternative medicine (CAM) (Pettman 2007) and its founder AT Still, who was a medical physician, also engaged in bone-setting, phrenology, and mesmerism (magnetic healing) (Trowbridge 1991). These practices (which are now considered as pseudoscientific) strongly influenced AT Still's thinking about health and healthcare and shaped his subsequent conception of osteopathy (Trowbridge 1991). It is plausible that threads of these pseudoscientific origins permeate through some elements of osteopathy today and manifest as some osteopaths being open to or engaging in, thinking and practice which lie outside of the scientific or the EBP domain. It is well documented that AT Still developed osteopathy in direct response to what he perceived to be the excessive and harmful use of medicine at the time (Baer 2006). For osteopathy to have such an adversarial arrival over a century ago may have influenced the attitudes of modern day osteopaths, whereby some practitioners may continue to be sceptical of medicine, medical research and medical treatments such as vaccines (Thomson et al. 2021; Al Janabi, Chinsky, and Pino 2021). There is also evidence that such feelings may be mutual, with Australian GPs holding negative views towards the osteopathic profession such as a lack of trust that care is safe or effective and a belief that there is insufficient evidence supporting osteopathic treatment (Engel, Beirman, and Grace 2016).

In recent times, osteopathy seems to straddle contemporary healthcare allied to medicine (e.g. the management of MSK-related pain) and CAM. Seminal sociological analysis from over twenty years ago (Lee-Treweek 2002) indicated that some of osteopathy's various sub-disciplines (e.g. cranial osteopathy) may be situated more clearly within the category of CAM, owing to the questionable methods, claimed mechanisms and effectiveness; and these have been considered 'fringe' in relation to other healthcare practices and even fringe in relation to more standard osteopathic practice (Lee-Treweek 2002). These more alternative claims and methods within osteopathy propose competing perspectives, theories and explanations of how entire bodily systems (and people) function, become sick and how treatment may (or may not) help. For example claiming the actual or potential effectiveness of osteopathy for addiction/substance abuse (Baron et al. 2018), traumatic brain injury (Pendlebury et al. 2022), and the association of osteopathic 'somatic dysfunction' (and treatment via osteopathic manipulative treatment - OMT) following infection from tick-bites (Unger, Palmer, and Thorsvik 2022). Such an 'anythingispossibilism' (Hildago et al.) stance towards mechanisms of illness and interventions results in a form of scientific pluralism, thereby making it a challenge for osteopathy and osteopaths to adhere to agreed scientific standards and where the resulting epistemic or knowledge 'gap' (Waterman 2022) may be filled by pseudoscience.

Whilst potentially all areas of osteopathic practice may be susceptible to pseudoscience and pseudoscientific claims, it is when osteopathy is conceived as 'full scope' healthcare (rather than defined as musculoskeletal care) and involving OMT to treat non-MSK related disorders including paediatric illnesses - that pseudoscience creeps in. Currently, the evidence of effectiveness of osteopathy for non-MSK and paediatric disorders is either weak, not proven or absent for conditions such as asthma (Jones et al. 2021), cerebral palsy (Wyatt et al. 2011), attention deficit hyperactivity disorder, (Accorsi et al. 2014), delayed speech development (Abramova and Aptekar 2020) and also colic/unsettledness (Buffone et al. 2022; Carnes et al. 2023). Further confirmation comes in the form of multiple systematic reviews which indicate that while generally safe (Ellwood, Draper-Rodi, and Carnes 2020; Carnes et al. 2018) the effectiveness for osteopathy for non-MSK and paediatric conditions is yet to be established (Franke, Franke, and Fryer 2022; Paul Posadzki, Lee, and Ernst 2013; Pawel Posadzki et al. 2022; Bagagiolo, Rosa, and Borrelli 2022). Particular caution is needed in these areas because osteopathy in the cranial field (OCF) is commonly associated with paediatric osteopathic care (albeit not necessarily defining it) and many of the fundamental assumptions and traditionally proposed mechanisms of OCF remain implausible and scientifically unproven. Examples of foundational claims which are commonly asserted to support the truthfulness of OCF (for a comprehensive list of mechanistic claims in relation to OCF see (Ferguson 2003)) include the palpable presence of the 'cranial rhythm' and Traube-Hering phenomenon, palpable movement of the cranial bones and sutures (which have a significant and meaningful impact on the development of disease), and palpable flow and restrictions of cerebrospinal fluid (CSF) - which cranial osteopaths have more recently grounded in the glymphatic system (Hitscherich et al. 2016). It is beyond the scope of this paper to rebut each individual claim of OCF. Nevertheless, there are a limited number of published research studies proposing to support some of the claims previously listed. Some examples include, presence of the cranial rhythm (Nelson et al. 2001), spontaneous movement of the cranial bones (Crow et al. 2009), reliable palpation of cranial suture restrictions (Demers et al. 2021), and that these restrictions are risk factors associated with health concerns (e.g. acute otitis media) (Morin et al. 2012). However, these are small, largely non-replicated studies, employing sometimes questionable methods, and often from highly invested authors. With this in mind, these aforementioned studies risk overinterpretation, overreaching and misinterpretation of data, failure to acknowledge limitations or a consideration of alternative (and more scientifically plausible) explanations of the results. Furthermore, despite its limitations, a systematic review indicates that such studies into OCF are highly biassed and of low quality and that cranial osteopathic methods are neither reliable nor effective (Guillaud et al. 2016). Therefore, rather than supporting the fundamental claims of OCF as being scientific, such small, low-quality and isolated studies are in fact hallmarks of pseudoscience (Shermer 2013), in so much as they "go well beyond the facts, make statements that are unverified or unfalsifiable, cherry-pick data, or fall into the bias of confirmation" (pg 216-217). Recently, a phenomenological thesis which focuses on the shared experience of OCF treatment and sense-making between patient and osteopath may (in part at least) avoid the need for some of these mechanistically questionable explanations and offer more plausible, sensible and scientifically coherent ways to understand and research OCF (Banton, Vogel, and Lee-Treweek 2023).

A foundational and historic idea of osteopathy is the concept of holism (Paulus 2013) ('it's *all* connected and therefore it *all* matters') (Hidalgo et al.). As such there is an epistemic burden for some osteopaths and osteopathy to strain every sinew to explain its claim of holistic care. There is a seemingly infinite number of possibilities which result from the complex interconnectedness of the 'body-mind-spirit' and which motivates the creation of elaborate explanatory frameworks to justify osteopathic clinical action (Turner and Holroyd 2016). Osteopathy is replete with far-reaching frameworks which have been put forward in an attempt to explain a person's interconnectedness (Esteves et al. 2020). In the pursuit to explain holism, some osteopaths appear to default to questionable and scientifically unsupported mechanisms to justify their 'osteopathic' assessment and treatment which include the ability to palpate and direct movement of cranial sutures (Sutherland 1997), manually influence the heart and pericardium (Bordoni et al. 2019), re-directing flow of the cerebral spinal fluid (Liem and van den Heede 2017), physically manipulate and influence brain structures (J.-P. Barral 2022; J. P. Barral and Croibier 2009), and manually communicating with the meninges via quantum physics (Bordoni, Morabito, and Simonelli 2019; Bordoni and Escher 2023). Notwithstanding that in our view, these claims range from speculative, to implausible to the frankly absurd; the 'integration problem' which describes the challenge faced by *all* healthcare professionals of coherently connecting an individual person's biological, psychological, and social processes in regards to their pain and illness - is well established (de Haan 2020). There a growing number of more scientifically plausible frameworks outside of osteopathic theory (Coninx and Stilwell 2021; Anjum, Copeland, and Rocca 2020), which attempt to address this perplexing yet crucial problem without the need for pseudoscientific leaps and it is encouraging that some of these are already being discussed in relation to osteopathic care (Cerritelli and Esteves 2022; Shaw et al. 2022).

In summary, many of the clinical entities, phenomena and mechanisms which form a core part of some elements of osteopathic practice, theory and identity are scientifically immeasurable, illusive and unfalsifiable. This presents a significant problem for osteopaths, educators and the profession when claiming scientific status whilst also promoting theories and mechanisms which seem not to conform to a scientific understanding of biological reality.

Primed for pseudoscience - regulation and professional factors

From a professional perspective there are regulatory and interdisciplinary forces which might leave osteopathy open to pseudoscience. Qualitative evidence indicates that ideological tensions exist amongst different manual therapy professionals (including osteopaths) when working together (Toloui-Wallace et al. 2022, 2023). Professional regulation may serve to soften some professional boundaries by aligning osteopathy with contemporary knowledge, practices, values and standards which are shared with other healthcare disciplines (Warren and Braithwaite 2020). Pressure to demonstrate inter-professional differences may be greater in countries where osteopathy is still emerging (or yet to emerge) as a profession and where osteopaths have to make a strong case to the respective authorities for the need for autonomous practice and regulatory governance. A strive to emphasise disciplinary specialness and the distinctiveness of osteopathy (compared with other similar health professions) may result in the promotion of implausible and pseudoscientific ideas as a way to highlight any distinguishing

features from other more established professions. An additional and related factor which might predispose osteopathy to pseudoscience are the attitudes and motivations of those enrolling in osteopathy training programmes and that ultimately make up the osteopathic workforce.

There is limited evidence on the psychological traits, beliefs and cognitions which motivate students to study osteopathy, however available evidence indicates osteopathic medical students in the US appear to have limited trust in the pharmaceutical and healthcare systems in relation to COVID-19 vaccines (Al Janabi, Chinsky, and Pino 2021). Students of other health professions (e.g. nursing, physiotherapy and radiography) who hold positive views towards CAM tend to have a less-scientific worldview (i.e. a worldview which opposes a scientific one) (Pettersen and Olsen 2007). Evidence on users of CAM might provide further insight. Systematic review evidence suggests users of CAM may be emotionally and intuitively drawn to CAM therapies and exhibit 'ontological confusion' meaning they are less able (or willing) to detect flaws or pseudoscientific elements inherent in healthcare treatments, such as claimed mechanisms and effects of which are not consistent with scientific explanations (Galbraith et al. 2018). If a sufficient number of people who hold such views and attitudes enrol onto osteopathy training programmes, then it may be postulated that it is not osteopathy *per se* that is at risk of pseudoscience, but the predisposition of its students. The question remains as to whether it is *osteopathy* with some of its associated history, theory and dogma that may facilitate pseudoscientific claims or is it that there is a large enough percentage of people *within* osteopathy that have the necessary traits and dispositions that facilitate pseudoscientific thinking, or perhaps a potent combination of *both*?

While the relationship between osteopathic regulation and practice is likely complex, there is some systematic review evidence to indicate that in countries where osteopathy is unregulated or early in its professionalisation (e.g in parts of Central Europe), non-MSK (and potentially less scientifically plausible) approaches such as cranial and visceral approaches appear relatively popular amongst osteopaths compared to osteopaths where professional regulation has been in place for longer and professionalisation is more established (for example the UK and Australia) (Ellwood and Carnes 2021). It is worth pointing out that there are likely other cultural and other more local factors which may contribute to the preservation and relatively frequent use of visceral and cranial approaches, despite professional regulation being in place, for example in Switzerland (Bill et al. 2020) and Portugal (Santiago et al. 2022). Moreover, regulation may enhance the quality of osteopathic training thereby developing the critical appraisal skills of osteopathic students (Luciani et al. 2015) making them more able to judge the credibility of knowledge and their detection of pseudoscience. Conversely, unintended consequences of regulation may be to shift pseudoscience to unregulated spaces (e.g. social media groups) or legitimise the fringe pseudoscientific elements of osteopathy. As can be seen, 'fringe treatment' seems to be a relative notion with respect to osteopathic methods and theories; what might be considered as pseudoscientific, alternative or fringe in one country may be considered entirely mainstream, accepted and standard osteopathic practice in another. More research is needed to better understand how the presence or absence of regulatory forces shape osteopaths' views of science, evidence and practice.

Finally, in countries where there is little or no professional regulation, there will likely be greater scope for pseudoscience to embed and thrive as the mechanisms which monitor the claims or practices

advertised by osteopaths (e.g. UK ASA (Committee of Advertising Practice n.d.)) will not be in place, nor will there be appropriate channels to report those osteopaths that spread pseudoscience and misinformation. Interestingly, there has been a recent discussion to develop robust regulatory standards of osteopathy in Spain (where osteopathy does not currently enjoy statutory regulation) with a specific aim to avoid the inclusion of pseudoscience in osteopathic practice, and a 'call to action' for the profession uniting to condemn misleading advertising (disinformation) and inaccurate information (misinformation) (Ciardo, Sánchez, and Fernández 2023).

Pseudoexpertise

Pseudoexpertise is often associated with pseudoscience and pseudoscientific claims and, in relation to osteopathy, often manifests as well-honed technical skills (e.g. manual therapy skills which can be applied to the specific structures in specific, discrete and even mysterious ways). As highlighted previously, examples of osteopaths' technical skills are claimed accuracy and precision in manual examination of miniscule motions of the spine, pelvis, contents of the skull and cranial sutures - often in the hollow pursuit to track down and treat 'somatic dysfunctions' (Tramontano et al. 2021), as well as extensive domain specific knowledge in the biomedical sciences such as anatomy, physiology, pathology and neurology many of which are emphasised in osteopathic education (MacMillan et al. 2023). Together, this allows osteopaths to speak and present their ideas as well as, or even better, than a scientist. Pseudoexperts are virtually unrecognisable as such by lay people (typically, patients), or even other experts - as they possess what is called 'interactional expertise' which is the ability to speak and interact *like* an expert (Collins and Evans 2008). Pseudoexpertise often exists because of a distinctive system of incentives and opportunities (Martini 2023b). Incentives are the fact that treatments for health concerns are typically in high demand, and evidence-based practice often does not yet have (fully) effective interventions. As a result, a gap is created that can easily be filled by people promising unexisting cures. Moreover, the possibility for pseudoexpertise is afforded by both a) laypeople's inability to distinguish between experts and pseudoexperts; b) delay in the visibility of a treatment's efficacy - i.e., the promise of a future cure can act as an asymmetry of information between the (presumed) health expert and the patient.

Recognising and countering pseudoscience

It is an ongoing challenge for healthcare practitioners to judge the veracity, credibility and trustworthiness of information and this is increasingly difficult given the ease at which evidence that claims to be 'scientific' can be published quickly in online predatory journals with little-to-no peer review or external validation and then widely disseminated and propagated via social media (Beall 2016). There is growing consensus amongst academic scholars that by publishing unscientific, low-quality and fabricated or false findings, predatory journals present a significant challenge across healthcare and scientific research (Grudniewicz et al. 2019; Oviedo-García 2021) and osteopaths and osteopathic researchers should be vigilant when consuming or seeking to publish research (for example, by checking www.predatoryreports.org). Many of the pseudoscientific claims and theories are so embedded and

normalised within osteopathic practice that they form practitioners' conception of clinical reality and it can be challenging to 'step outside' of one's own perspective and recognise erroneous beliefs. Critical discussion and observations of practice with colleagues is a useful way to 'see' knowledge and practice in different ways and become aware of deeply held biases, assumptions and blind-spots in practice (Petty and Morley 2009). Recently, there is a resource published to support osteopaths in critically assessing the quality of information they are exposed to (Draper-Rodi et al. 2022).

Even if pseudoscientific views and practices are 'fringe', held by a 'loud minority' or are not representative of the wider osteopathic profession, they have the potential to cast doubt and raise questions as to the credibility of osteopathy and damage the reputation of osteopathy as a contemporary ethical health profession. Such reputational damage harms both established osteopathic professions in regards to negatively impacting healthcare and research funding, policymaking and opportunities (e.g. interprofessional collaboration) but also may hamper the efforts of those lobbying for regulation in countries where osteopathy remains unregulated; here pseudoscientific claims from osteopaths may cause concern for healthcare authorities and possibly question whether the recognition of osteopathy as a 'profession' is deserved.

The osteopathic research, education and practice communities should work together to promote high quality, credible and scientifically robust evidence and at the same time recognise the harm in disseminating implausible, untrustworthy and pseudoscientific knowledge in the course of its practice, education and professional promotion/communication. Moderating views on social media groups is a significant challenge, and the practice of debunking (retrospective countering/correction of misinformation) has been shown to have dangerous backfire effects (Lewandowsky, Cook, and Lombardi 2020) and it can potentially strengthen, rather than reduce, misconceptions. However, administrators and members of osteopathy social media groups should be wary of enabling the propagation of, or complicitly endorsing pseudoscience and misinformation in the spirit of 'osteopathic exploration' or 'open mindedness'. In order to enable osteopaths to recognise pseudoscience and misinformation, osteopathic associations and institutions should educate its members about specific strategies to help critical evaluation of sources, such as 'lateral reading' (checking information in multiple sources (Panizza et al. 2022), and verifying a source's standing within the scientific community, its track record, its possible conflicts of interests, etc. Such efforts will include continued work to enhance the critical appraisal skills of osteopaths and students to recognise pseudoscience. Finally, osteopathic educational institutions, associations and conference organisers should resist the temptation to promote, give voice and a platform to those (often well-known) individuals to spread misinformation in their teaching and presentations.

Conclusion

This paper has introduced the concept of pseudoscience, and its potential to result in significant negative impacts on patient care, osteopathy and society more broadly. The utilisation and propagation of pseudoscience by healthcare disciplines such as osteopathy, raises questions in regards to their

professional legitimacy and ethical standing. There are forces and factors which may motivate some osteopaths to put forward pseudoscientific claims and make osteopathy susceptible to pseudoscience. As healthcare professionals and healthcare experts, osteopaths must be critically aware of the quality of the knowledge which informs and is communicated in their practice. The profession must continue to critically reflect on ideas, models and theories which are promoted in osteopathic practice and education yet seem to violate scientific knowledge and understanding. A failure to do so jeopardises osteopathy's claim as a legitimate profession and threatens the privileged opportunity to provide safe, effective and ethical healthcare.

References

Abramova, E. V., and I. A. Aptekar. 2020. "Osteopathic Correction of Somatic Dysfunctions in Preschool Children with Delayed Speech Development." *Russian Osteopathic Journal*, no. 3-4 (February): 54–61.

Accorsi, Alessandro, Chiara Lucci, Lorenzo Di Mattia, Cristina Granchelli, Gina Barlafante, Federica Fini, Gianfranco Pizzolorusso, Francesco Cerritelli, and Maurizio Pincherle. 2014. "Effect of Osteopathic Manipulative Therapy in the Attentive Performance of Children with Attention-Deficit/hyperactivity Disorder." *The Journal of the American Osteopathic Association* 114 (5): 374–81.

Al Janabi, Taysir, Ravi Chinsky, and Maria A. Pino. 2021. "Perceptions of COVID-19 Vaccines among Osteopathic Medical Students (OMS)." *International Journal of Osteopathic Medicine: IJOM* 42 (December): 23–28.

Alvarez, Gerard, Cristian Justribo, Tobias Sundberg, Oliver P. Thomson, and Matthew J. Leach. 2021. "A National Cross-Sectional Survey of the Attitudes, Skills and Use of Evidence-Based Practice amongst Spanish Osteopaths." *BMC Health Services Research* 21 (1): 130.

Anjum, Rani Lill, Samantha Copeland, and Elena Rocca. 2020. *Rethinking Causality, Complexity and Evidence for the Unique Patient: A CauseHealth Resource for Healthcare Professionals and the Clinical Encounter*. Springer Nature.

Axén, Iben, Cecilia Bergström, Marc Bronson, Pierre Côté, Casper Glissmann Nim, Guillaume Goncalves, Jeffrey J. Hébert, et al. 2020. "Misinformation, Chiropractic, and the COVID-19 Pandemic." *Chiropractic & Manual Therapies* 28 (1): 65.

Baer, Hans A. 2006. "The Drive for Legitimation by Osteopathy and Chiropractic in Australia: Between Heterodoxy and Orthodoxy." *Complementary Health Practice Review* 11 (2): 77–94.

Bagagiolo, Donatella, Debora Rosa, and Francesca Borrelli. 2022. "Efficacy and Safety of Osteopathic Manipulative Treatment: An Overview of Systematic Reviews." *BMJ Open* 12 (4): e053468.

Banton, Amanda, and Steven Vogel. 2023. "Relational Clinical Practice: A Hermeneutic, Enactive, Intersubjective Model of Osteopathy." *International Journal of Osteopathic Medicine: IJOM*, December, 100707.

Banton, Amanda, Steven Vogel, and Geraldine Lee-Treweek. 2023. "Making Sense of Cranial Osteopathy: An Interpretative Phenomenological Analysis." *International Journal of Osteopathic Medicine: IJOM* 50 (December): 100673.

Baron, Dave, Kenneth Blum, Anthony Chen, Mark Gold, and Rajendra D. Badgaiyan. 2018. "Conceptualizing Addiction From an Osteopathic Perspective: Dopamine Homeostasis." *The Journal of the American Osteopathic Association* 118 (2): 115–18.

Barral, Jean-Pierre. 2022. *Manual Therapy Approach to the Brain - Volume 1*. Barral Productions.

Barral, J. P., and Alain Croibier. 2009. *Manual Therapy for the Cranial Nerves*. Elsevier.
Beall, Jeffrey. 2016. “Dangerous Predatory Publishers Threaten Medical Research.” *Journal of Korean Medical Science* 31 (10): 1511–13.
Bill, Anne-Sylvie, Julie Dubois, Jérôme Pasquier, Bernard Burnand, and Pierre-Yves Rodondi. 2020. “Osteopathy in the French-Speaking Part of Switzerland: Practitioners’ Profile and Scope of Back Pain Management.” *PloS One* 15 (5): e0232607.
Blaich, R., N. Pather, and K. Luo. 2019. “Australian Osteopathic Practitioners’ Perceptions of the Clinical Relevance of Anatomy.” *International Journal of*. https://researchportal.scu.edu.au/esploro/outputs/journalArticle/Australian-Osteopathic-Practitioners-Perceptions-of-the/991012926975802368.
Bledsoe, Bryan E. 2004. “The Elephant in the Room: Does OMT Have Proved Benefit?” *International Journal of Osteopathic Medicine: IJOM* 104 (10): 405–6.
Bordoni, Bruno, and Allan R. Escher. 2023. “The Osteopath’s Imprint: Osteopathic Medicine Under the Nanoscopic Lens.” *Cureus* 15 (1): e33914.
Bordoni, Bruno, Bruno Morabito, and Marta Simonelli. 2019. “Cranial Osteopathy: Obscurantism and Enlightenment.” *Cureus* 11 (5): e4730.
Bordoni, Bruno, Bruno Morabito, Marta Simonelli, Luigi Nicoletti, Riccardo Rinaldi, Filippo Tobbi, and Philippe Caiazzo. 2019. “Osteopathic Approach with a Patient Undergoing Cardiac Transplantation: The Five Diaphragms.” *International Medical Case Reports Journal* 12 (September): 303–8.
Buffone, Francesca, Domenico Monacis, Andrea Gianmaria Tarantino, Fulvio Dal Farra, Andrea Bergna, Massimo Agosti, and Luca Vismara. 2022. “Osteopathic Treatment for Gastrointestinal Disorders in Term and Preterm Infants: A Systematic Review and Meta-Analysis.” *Healthcare (Basel, Switzerland)* 10 (8). https://doi.org/10.3390/healthcare10081525.
Cant, Sarah L., and Ursula Sharma. 1996. “Professionalization of Complementary Medicine in the United Kingdom.” *Complementary Therapies in Medicine* 4 (3): 157–62.
Carnes, Dawn, Philip Bright, Kevin Brownhill, Karen Carroll, Roger Engel, Sandra Grace, Steven Vogel, and Paul Vaucher. 2023. “Usual Light Touch Osteopathic Treatment versus Simple Light Touch without Intent in the Reduction of Infantile Colic Crying Time: A Randomised Controlled Trial.” https://doi.org/10.21203/rs.3.rs-2503943/v1.
Carnes, Dawn, Austin Plunkett, Julie Ellwood, and Clare Miles. 2018. “Manual Therapy for Unsettled, Distressed and Excessively Crying Infants: A Systematic Review and Meta-Analyses.” *BMJ Open* 8 (1): e019040.
Cerritelli, Francesco, and Jorge E. Esteves. 2022. “An Enactive-Ecological Model to Guide Patient-Centered Osteopathic Care.” *Healthcare (Basel, Switzerland)* 10 (6). https://doi.org/10.3390/healthcare10061092.
Cerritelli, Francesco, Alessio Iacopini, Matteo Galli, Oliver P. Thomson, Tobias Sundberg, Matthew J. Leach, and Jon Adams. 2021. “Evidence-Based Practice among Italian Osteopaths: A National Cross-Sectional Survey.” *BMC Complementary Medicine and Therapies* 21 (1): 252.
Chalmers, Alan F. 2013. *What Is This Thing Called Science?* Hackett Publishing.
Chigwedere, Pride, George R. Seage 3rd, Sofia Gruskin, Tun-Hou Lee, and M. Essex. 2008. “Estimating the Lost Benefits of Antiretroviral Drug Use in South Africa.” *Journal of Acquired Immune Deficiency Syndromes* 49 (4): 410–15.
Ciardo, Antonio, Mar García Sánchez, and Moisés Cobo Fernández. 2023. “The Importance of Constructing an Osteopathic Profession around Modern Common Academic Values and Avoiding Pseudoscience: The Spanish Experience.” *Advances in Integrative Medicine*, September. https://doi.org/10.1016/j.aimed.2023.09.003.
Clark, Chalmers C. 2002. “Trust in Medicine.” *The Journal of Medicine and Philosophy* 27 (1): 11–29.
Clifford, A., A. Segal, A. Guterres, and P. J. Orrock. 2022. “An Exploration of the Clinical Reasoning Used by

Registered Osteopaths in Their Choice of Therapeutic Approach." *International Journal of Osteopathic Medicine: IJOM* 46 (December): 19–28.
Collins, Harry, and Robert Evans. 2008. *Rethinking Expertise*. University of Chicago Press.
Committee of Advertising Practice. n.d. "Health: Osteopathy." Accessed January 12, 2023. https://www.asa.org.uk/advice-online/health-osteopathy.html.
Coninx, Sabrina, and Peter Stilwell. 2021. "Pain and the Field of Affordances: An Enactive Approach to Acute and Chronic Pain." *Synthese* 199 (3): 7835–63.
Crow, William T., Hollis H. King, Rita M. Patterson, and Vincent Giuliano. 2009. "Assessment of Calvarial Structure Motion by MRI." *Osteopathic Medicine and Primary Care* 3 (September): 8.
Debray, Stéphanie. 2018. "Le problème de la démarcation: Sciences, Pseudo-sciences, Parasciences." In *Journées scientifiques des Archives Henri-Poincaré (JSAP) 2018-2*. https://hal.science/hal-03207236/.
Demers, Kyla, Chantal Morin, Louise Collette, and Richard DeMont. 2021. "Moderate to Substantial Inter-Rater Reliability in the Assessment of Cranial Bone Mobility Restrictions." *Journal of Alternative and Complementary Medicine* 27 (3): 263–72.
Draper-Rodi, Jerry, Paul Vaucher, David Hohenschurz-Schmidt, Chantal Morin, and Oliver P. Thomson. 2022. "4 M's to Make Sense of Evidence – Avoiding the Propagation of Mistakes, Misinterpretation, Misrepresentation and Misinformation." *International Journal of Osteopathic Medicine: IJOM* 44 (June): 29–35.
Ellwood, Julie, and Dawn Carnes. 2021. "An International Profile of the Practice of Osteopaths: A Systematic Review of Surveys." *International Journal of Osteopathic Medicine: IJOM* 40 (June): 14–21.
Ellwood, Julie, Jerry Draper-Rodi, and Dawn Carnes. 2020. "The Effectiveness and Safety of Conservative Interventions for Positional Plagiocephaly and Congenital Muscular Torticollis: A Synthesis of Systematic Reviews and Guidance." *Chiropractic & Manual Therapies* 28 (1): 31.
Engel, Roger M., Robyn Beirman, and Sandra Grace. 2016. "An Indication of Current Views of Australian General Practitioners towards Chiropractic and Osteopathy: A Cross-Sectional Study." *Chiropractic & Manual Therapies* 24 (November): 37.
Ernst, E. 2002. "A Systematic Review of Systematic Reviews of Homeopathy." *British Journal of Clinical Pharmacology* 54 (6): 577–82.
Esteves, Jorge E., Francesco Cerritelli, Joohan Kim, and Karl J. Friston. 2022. "Osteopathic Care as (En)active Inference: A Theoretical Framework for Developing an Integrative Hypothesis in Osteopathy." *Frontiers in Psychology* 13 (February): 812926.
Esteves, Jorge E., Rafael Zegarra-Parodi, Patrick van Dun, Francesco Cerritelli, and Paul Vaucher. 2020. "Models and Theoretical Frameworks for Osteopathic Care – A Critical View and Call for Updates and Research." *International Journal of Osteopathic Medicine: IJOM* 35 (March): 1–4.
Fasce, Angelo, and Alfonso Picó. 2019. "Conceptual Foundations and Validation of the Pseudoscientific Belief Scale." *Applied Cognitive Psychology*, January. https://doi.org/10.1002/acp.3501.
Ferguson, Andrew. 2003. "A Review of the Physiology of Cranial Osteopathy." *International Journal of Osteopathic Medicine: IJOM* 6 (2): 74–84.
Figg-Latham, Joanna, and Dévan Rajendran. 2017. "Quiet Dissent: The Attitudes, Beliefs and Behaviours of UK Osteopaths Who Reject Low Back Pain Guidance - A Qualitative Study." *Musculoskeletal Science & Practice* 27 (February): 97–105.
Franke, Helge, Jan-David Franke, and Gary Fryer. 2022. "Effectiveness of Osteopathic Manipulative Treatment for Pediatric Conditions: A Systematic Review." *Journal of Bodywork and Movement Therapies* 31 (July): 113–33.
Galbraith, Niall, Tim Moss, Victoria Galbraith, and Satvinder Purewal. 2018. "A Systematic Review of the Traits and Cognitions Associated with Use of and Belief in Complementary and Alternative Medicine

(CAM)." *Psychology, Health & Medicine* 23 (7): 854–69.
Gevitz, Norman. 2019. *The DOs: Osteopathic Medicine in America*. JHU Press.
Grace, Sandra, Paul Orrock, Brett Vaughan, Raymond Blaich, and Rosanne Coutts. 2016. "Understanding Clinical Reasoning in Osteopathy: A Qualitative Research Approach." *Chiropractic & Manual Therapies* 24 (March): 6.
Greenhalgh, Trisha, Jeremy Howick, Neal Maskrey, and Evidence Based Medicine Renaissance Group. 2014. "Evidence Based Medicine: A Movement in Crisis?" *BMJ* 348 (June): g3725.
Grimes, David Robert. 2012. "Proposed Mechanisms for Homeopathy Are Physically Impossible." *Focus on Alternative and Complementary Therapies: FACT / Dept. of Complementary Medicine, Postgraduate Medical School, University of Exeter* 17 (3): 149–55.
Grudniewicz, Agnes, David Moher, Kelly D. Cobey, Gregory L. Bryson, Samantha Cukier, Kristiann Allen, Clare Ardern, et al. 2019. "Predatory Journals: No Definition, No Defence." *Nature* 576 (7786): 210–12.
Guillaud, Albin, Nelly Darbois, Richard Monvoisin, and Nicolas Pinsault. 2016. "Reliability of Diagnosis and Clinical Efficacy of Cranial Osteopathy: A Systematic Review." *PloS One* 11 (12): e0167823.
Haan, Sanneke de. 2020. "An Enactive Approach to Psychiatry." *Philosophy, Psychiatry, & Psychology: PPP* 27 (1): 3–25.
Higgs, Joy, Barbara Richardson, and Madeleine Abrandt Dahlgren. 2004. *Developing Practice Knowledge for Health Professionals*. Butterworth-Heinemann.
Hildago, D, MacMillan A, Thomson O.P. 'It's *all* connected, so it *all* matters' - the fallacy of osteopathic anatomical possibilism. *International Journal of Osteopathic Medicine: IJOM* https://doi.org/10.1016/j.ijosm.2024.100718
Hitscherich, Kyle, Kyle Smith, Joshua A. Cuoco, Kathryn E. Ruvolo, Jayme D. Mancini, Joerg R. Leheste, and German Torres. 2016. "The Glymphatic-Lymphatic Continuum: Opportunities for Osteopathic Manipulative Medicine." *The Journal of the American Osteopathic Association* 116 (3): 170–77.
Hohenschurz-Schmidt, David, Lene Vase, Whitney Scott, Marco Annoni, Oluwafemi K. Ajayi, Jürgen Barth, Kim Bennell, et al. 2023. "Recommendations for the Development, Implementation, and Reporting of Control Interventions in Efficacy and Mechanistic Trials of Physical, Psychological, and Self-Management Therapies: The CoPPS Statement." *BMJ* 381 (May): e072108.
Huijbregts, Peter A. 2005. "The Chiropractic Subluxation: Implications for Manual Medicine." *The Journal of Manual & Manipulative Therapy* 13 (3): 139–41.
Inman, John, and Oliver P. Thomson. 2019. "Complementing or Conflicting? A Qualitative Study of Osteopaths' Perceptions of NICE Low Back Pain and Sciatica Guidelines in the UK." *International Journal of Osteopathic Medicine: IJOM* 31 (March): 7–14.
Jones, Laquita M., Christopher Regan, Kimberly Wolf, Jenifer Bryant, Alexander Rakowsky, Melissa Pe, and Dane A. Snyder. 2021. "Effect of Osteopathic Manipulative Treatment on Pulmonary Function Testing in Children with Asthma." *Journal of Osteopathic Medicine* 121 (6): 589–96.
Kasiri-Martino, Hannah, and Philip Bright. 2016. "Osteopathic Educators' Attitudes towards Osteopathic Principles and Their Application in Clinical Practice: A Qualitative Inquiry." *Manual Therapy* 21 (February): 233–40.
Kawchuk, Greg, Jan Hartvigsen, Steen Harsted, Casper Glissmann Nim, and Luana Nyirö. 2020. "Misinformation about Spinal Manipulation and Boosting Immunity: An Analysis of Twitter Activity during the COVID-19 Crisis." *Chiropractic & Manual Therapies* 28 (1): 34.
Kawchuk, Gregory Neil, Steen Harsted, Jan Hartvigsen, Luana Nyirö, and Casper Glissmann Nim. 2023. "A Two-Year Follow-up: Twitter Activity Regarding Misinformation about Spinal Manipulation, Chiropractic Care and Boosting Immunity during the COVID-19 Pandemic." *Chiropractic & Manual Therapies* 31 (1): 4.
Kelley, John M., Gordon Kraft-Todd, Lidia Schapira, Joe Kossowsky, and Helen Riess. 2014. "The Influence

of the Patient-Clinician Relationship on Healthcare Outcomes: A Systematic Review and Meta-Analysis of Randomized Controlled Trials." *PloS One* 9 (4): e94207.
Kerry, Roger. 2017. "Expanding Our Perspectives on Research in Musculoskeletal Science and Practice." *Musculoskeletal Science & Practice* 32 (December): 114–19.
Lakatos, Imre, and Alan Musgrave. 1970. *Criticism and the Growth of Knowledge: Volume 4: Proceedings of the International Colloquium in the Philosophy of Science, London, 1965*. Cambridge University Press.
Laudan, Larry. 1983. "The Demise of the Demarcation Problem." In *Physics, Philosophy and Psychoanalysis: Essays in Honour of Adolf Grünbaum*, edited by R. S. Cohen and L. Laudan, 111–27. Dordrecht: Springer Netherlands.
Leach, Janine. 2008. "Towards an Osteopathic Understanding of Evidence." *International Journal of Osteopathic Medicine: IJOM* 11 (1): 3–6.
Leach, Matthew J., Robert Shaw, Phil Austin, Gary Fryer, Oliver P. Thomson, Jon Adams, Eva Skillgate, and Tobias Sundberg. 2020. "Attitudes, Skills, and Use of Evidence-Based Practice: A Cross-Sectional Survey of Swedish Osteopaths." *International Journal of Osteopathic Medicine: IJOM* 38 (December): 41–49.
Leach, Matthew J., Tobias Sundberg, Gary Fryer, Philip Austin, Oliver P. Thomson, and Jon Adams. 2019. "An Investigation of Australian Osteopaths' Attitudes, Skills and Utilisation of Evidence-Based Practice: A National Cross-Sectional Survey." *BMC Health Services Research* 19 (1): 498.
Lee-Treweek, Geraldine. 2002. "Trust in Complementary Medicine: The Case of Cranial Osteopathy." *The Sociological Review* 50 (1): 48–68.
Lewandowsky, Stephan, John Cook, and Doug Lombardi. 2020. "Debunking Handbook 2020." Databrary. https://doi.org/10.17910/B7.1182.
L'Hermite, Pierre-Luc. 2020. *Introduction à la science ostéopathique - Approche épistémologique*. Editions Ellipses.
Licciardone, John C. 2008. "Educating Osteopaths to Be Researchers - What Role Should Research Methods and Statistics Have in an Undergraduate Curriculum?" *International Journal of Osteopathic Medicine: IJOM* 11 (2): 62–68.
Licciardone, John C., Cathleen M. Kearns, and Dennis E. Minotti. 2013. "Outcomes of Osteopathic Manual Treatment for Chronic Low Back Pain according to Baseline Pain Severity: Results from the OSTEOPATHIC Trial." *Manual Therapy* 18 (6): 533–40.
Liem, Torsten, and Patrick van den Heede. 2017. *Foundations of Morphodynamics in Osteopathy: An Integrative Approach to Cranium, Nervous System, and Emotions*. Jessica Kingsley Publishers.
Longino, Helen E. 2020. *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton University Press.
Lucas, Nicholas P., and Robert W. Moran. 2007. "Is There a Place for Science in the Definition of Osteopathy?" *International Journal of Osteopathic Medicine: IJOM* 10 (4): 85–87.
Luciani, Emanuele, Patrick L. S. van Dun, Jorge Eduardo Esteves, Christian Lunghi, Marco Petracca, Liria Papa, Olivier Merdy, Anne Jäkel, and Francesco Cerritelli. 2015. "Learning Environment, Preparedness and Satisfaction in Osteopathy in Europe: The PreSS Study." *PloS One* 10 (6): e0129904.
MacMillan, Andrew, Patrick Gauthier, Lucianne Alberto, Rachel Ives, Chris Williams, and Dr Jerry Draper-Rodi. 2023. "Osteopathic Education: A Scoping Review." *International Journal of Osteopathic Medicine: IJOM*, March, 100663.
Martini, Carlo. 2023a. "Abductive Reasoning in Clinical Diagnostics." In *Handbook of Abductive Cognition*, edited by Lorenzo Magnani, 467–79. Cham: Springer International Publishing.
———. 2023b. "Who Are the Economic Experts? How Can One Tell?" In *Making Economics Public*, edited by Fabien Medvecky and Vicki Macknight. Routledge, Chapman & Hall, Incorporated.

McGrath, Maurice Christopher. 2015. “A Global View of Osteopathic Practice – Mirror or Echo Chamber?” *International Journal of Osteopathic Medicine: IJOM* 18 (2): 130–40.
Morin, Chantal, Dominique Dorion, Jean-Marie Moutquin, and Mélanie Levasseur. 2012. “Suture Restriction of the Temporal Bone as a Risk Factor for Acute Otitis Media in Children: Cohort Study.” *BMC Pediatrics* 12 (November): 181.
Mukerji, Nikil, and Edzard Ernst. 2022. “Why Homoeopathy Is Pseudoscience.” *Synthese* 200 (5): 394.
Nelson, K. E., N. Sergueef, C. M. Lipinski, A. R. Chapman, and T. Glonek. 2001. “Cranial Rhythmic Impulse Related to the Traube-Hering-Mayer Oscillation: Comparing Laser-Doppler Flowmetry and Palpation.” *The Journal of the American Osteopathic Association* 101 (3): 163–73.
Nguyen, Christelle, Isabelle Boutron, Rafael Zegarra-Parodi, Gabriel Baron, Sophie Alami, Katherine Sanchez, Camille Daste, et al. 2021. “Effect of Osteopathic Manipulative Treatment vs Sham Treatment on Activity Limitations in Patients With Nonspecific Subacute and Chronic Low Back Pain: A Randomized Clinical Trial.” *JAMA Internal Medicine* 181 (5): 620–30.
Oviedo-García, M. Ángeles. 2021. “Journal Citation Reports and the Definition of a Predatory Journal: The Case of the Multidisciplinary Digital Publishing Institute (MDPI).” *Research Evaluation* 30 (3): 405–19a.
Panizza, Folco, Piero Ronzani, Carlo Martini, Simone Mattavelli, Tiffany Morisseau, and Matteo Motterlini. 2022. “Lateral Reading and Monetary Incentives to Spot Disinformation about Science.” *Scientific Reports* 12 (1): 5678.
Paulus, Stephen. 2013. “The Core Principles of Osteopathic Philosophy.” *International Journal of Osteopathic Medicine: IJOM* 16 (1): 11–16.
Pendlebury, Gehan A., Peter Oro, William Haynes, Thomas R. Byrnes, James Keane, and Leonard Goldstein. 2022. “Advocacy for Change: An Osteopathic Review of Traumatic Brain Injury Among Combat Veterans.” *Cureus* 14 (5): e25051.
Pettersen, Sverre, and Rolf V. Olsen. 2007. “Exploring Predictors of Health Sciences Students’ Attitudes Towards Complementary-Alternative Medicine.” *Advances in Health Sciences Education: Theory and Practice* 12 (1): 35–53.
Pettman, Erland. 2007. “A History of Manipulative Therapy.” *The Journal of Manual & Manipulative Therapy* 15 (3): 165–74.
Petty, Nicola J., and Mary Morley. 2009. “Clinical Expertise: Learning Together through Observed Practice.” *Manual Therapy* 14 (5): 461–62.
Pigliucci, Massimo. 2018. *Nonsense on Stilts: How to Tell Science from Bunk*. University of Chicago Press.
Pigliucci, Massimo, and Maarten Boudry. 2013. *Philosophy of Pseudoscience: Reconsidering the Demarcation Problem*. University of Chicago Press.
Popper, Karl R. 1963. “Science as Falsification.” *Conjectures and Refutations* 1 (1963): 33–39.
Posadzki, Paul, Myeong Soo Lee, and Edzard Ernst. 2013. “Osteopathic Manipulative Treatment for Pediatric Conditions: A Systematic Review.” *Pediatrics* 132 (1): 140–52.
Posadzki, Pawel, Bhone Myint Kyaw, Arkadiusz Dziedzic, and Edzard Ernst. 2022. “Osteopathic Manipulative Treatment for Pediatric Conditions: An Update of Systematic Review and Meta-Analysis.” *Journal of Clinical Medicine Research* 11 (15). https://doi.org/10.3390/jcm11154455.
Roots, Simon A., Elizabeth Niven, and Robert W. Moran. 2016. “Osteopaths’ Clinical Reasoning during Consultation with Patients Experiencing Acute Low Back Pain: A Qualitative Case Study Approach.” *International Journal of Osteopathic Medicine: IJOM* 19 (March): 20–34.
Santiago, Rui José, Alexandre Nunes, Jorge Eduardo Esteves, Francesco Cerritelli, Johan Verbeeck, Sónia Lopes, Manuel Paquete, and Patrick van Dun. 2022. “The Portuguese Osteopathic Practitioners Estimates and RAtes (OPERA): A Cross-Sectional Survey.” *International Journal of Osteopathic Medicine: IJOM* 43 (March): 23–30.

Shaw, Robert, Hilary Abbey, Sergi Casals-Gutiérrez, and Sanja Maretic. 2022. “Reconceptualizing the Therapeutic Alliance in Osteopathic Practice: Integrating Insights from Phenomenology, Psychology and Enactive Inference.” *International Journal of Osteopathic Medicine: IJOM* 46 (December): 36–44.

Shermer, Michael. 2013. “Science and Pseudoscience the Difference in Practice and the Difference/T Makes.” In *Philosophy of Pseudoscience: Reconsidering the Demarcation Problem*, edited by Massimo Pigliucci and Maarten Boudry, 203. University of Chicago Press.

Smith, Kevin. 2012. “Homeopathy Is Unscientific and Unethical.” *Bioethics* 26 (9): 508–12.

Solomon, Miriam. 2015. *Making Medical Knowledge*. Oxford University Press.

Steel, Amie, Raymond Blaich, Tobias Sundberg, and Jon Adams. 2017. “The Role of Osteopathy in Clinical Care: Broadening the Evidence-Base.” *International Journal of Osteopathic Medicine: IJOM* 24 (June): 32–36.

Still, A. T. 1910. *Osteopathy, Research and Practice*. CreateSpace Independent Publishing Platform.

Sundberg, Tobias, Matthew J. Leach, Oliver P. Thomson, Philip Austin, Gary Fryer, and Jon Adams. 2018. “Attitudes, Skills and Use of Evidence-Based Practice among UK Osteopaths: A National Cross-Sectional Survey.” *BMC Musculoskeletal Disorders* 19 (1): 439.

Sutherland, William Garner. 1997. *Contributions of Thought: A Collected Writings of William Garner Sutherland*. Rudra Press.

Swire-Thompson, Briony, and David Lazer. 2020. “Public Health and Online Misinformation: Challenges and Recommendations.” *Annual Review of Public Health* 41 (April): 433–51.

Teplinsky, Eleonora, Sara Beltrán Ponce, Emily K. Drake, Ann Meredith Garcia, Stacy Loeb, G. J. van Londen, Deanna Teoh, Michael Thompson, Lidia Schapira, and Collaboration for Outcomes using Social Media in Oncology (COSMO). 2022. “Online Medical Misinformation in Cancer: Distinguishing Fact From Fiction.” *JCO Oncology Practice* 18 (8): 584–89.

“The OIA Global Report: Global Review of Osteopathic Medicine and Osteopathy 2020 – Osteopathic International Alliance.” n.d. Accessed November 17, 2021. https://oialliance.org/the-oia-global-report-global-review-of-osteopathic-medicine-and-osteopathy-2020/.

Thomson, Oliver P., and Andrew MacMillan. 2023. “What’s Wrong with Osteopathy?” *International Journal of Osteopathic Medicine: IJOM* 48 (June): 100659.

Thomson, Oliver P., Andrew MacMillan, Jerry Draper-Rodi, Paul Vaucher, Mathieu Ménard, Brett Vaughan, Chantal Morin, et al. 2021. “Opposing Vaccine Hesitancy during the COVID-19 Pandemic - A Critical Commentary and United Statement of an International Osteopathic Research Community.” *International Journal of Osteopathic Medicine: IJOM* 39 (March): A1–6.

Thomson, Oliver P., Nicola J. Petty, and Ann P. Moore. 2014a. “Clinical Decision-Making and Therapeutic Approaches in Osteopathy - a Qualitative Grounded Theory Study.” *Manual Therapy* 19 (1): 44–51.

———. 2014b. “Diagnostic Reasoning in Osteopathy – A Qualitative Study.” *International Journal of Osteopathic Medicine: IJOM* 17 (2): 83–93.

Toloui-Wallace, Joshua, Roma Forbes, Oliver P. Thomson, and Nathalia Costa. 2023. “Fluid Boundaries: Ethnographic Observations of Co-Located Physiotherapists, Chiropractors, and Osteopaths.” *Research Square*. https://doi.org/10.21203/rs.3.rs-3638113/v1.

Toloui-Wallace, Joshua, Roma Forbes, Oliver P. Thomson, and Jenny Setchell. 2022. “When Worlds Collide: Experiences of Physiotherapists, Chiropractors, and Osteopaths Working Together.” *Musculoskeletal Science & Practice* 60 (August): 102564.

Tramontano, Marco, Federica Tamburella, Fulvio Dal Farra, Andrea Bergna, Christian Lunghi, Mattia Innocenti, Fabio Cavera, Federica Savini, Vincenzo Manzo, and Giandomenico D’Alessandro. 2021. “International Overview of Somatic Dysfunction Assessment and Treatment in Osteopathic Research: A Scoping Review.” *Healthcare (Basel, Switzerland)* 10 (1).

https://doi.org/10.3390/healthcare10010028.
Trowbridge, C. 1991. *Still 1828--1917*. Kirksville, Mo: Thomas Jefferson University Press.
"Trust in Science and Changing Landscapes of Communication." 2019. ALLEA. January 5, 2019. https://allea.org/portfolio-item/trust-in-science-and-changing-landscapes-of-communication/.
Turner, Paul W. D., and Eleanor Holroyd. 2016. "Holism in Osteopathy – Bridging the Gap between Concept and Practice: A Grounded Theory Study." *International Journal of Osteopathic Medicine: IJOM* 22 (December): 40–51.
Tyreman, Stephen. 2008. "Commentary on 'Is There a Place for Science in the Definition of Osteopathy'?" *International Journal of Osteopathic Medicine: IJOM* 11 (3): 102–5.
———. 2011. "Values in Complementary and Alternative Medicine." *Medicine, Health Care, and Philosophy* 14 (2): 209–17.
Unger, Mark D., Joy L. Palmer, and Nichole M. Thorsvik. 2022. "Incidence Rate of Somatic Dysfunction in Previously Undiagnosed Spotted Fever Rickettsiosis: A Case Report." *Cureus* 14 (4): e24416.
Vaughan, Brett, Sandra Grace, Bimbi Gray, and Andre Kleinbaum. 2019. "Engaging with Evidence-Based Practice in the Osteopathy Clinical Learning Environment: A Mixed Methods Pilot Study." *International Journal of Osteopathic Medicine: IJOM* 33-34 (September): 52–58.
Vaughan, Brett, Robert Moran, Philip Tehan, Gary Fryer, Mat Holmes, Steven Vogel, and Alan Taylor. 2016. "Manual Therapy and Cervical Artery Dysfunction: Identification of Potential Risk Factors in Clinical Encounters." *International Journal of Osteopathic Medicine: IJOM* 21 (September): 40–50.
Vaughan, Brett, Vivienne Sullivan, Cameron Gosling, Patrick McLaughlin, Gary Fryer, Margaret Wolff, and Roger Gabb. 2012. "Methods of Assessment Used by Osteopathic Educational Institutions." *International Journal of Osteopathic Medicine: IJOM* 15 (4): 134–51.
Vogel, Steven. 2021. "W(h)ither Osteopathy: A Call for Reflection; a Call for Submissions for a Special Issue." *International Journal of Osteopathic Medicine: IJOM* 41 (September): 1–3.
Warren, Michael, and Christine Braithwaite. 2020. "Understanding the Relationship Between Professional Regulation and Professional Identity in Health Care." *Journal of Medical Regulation* 106 (2): 7–14.
Waterman, Scott G. 2022. "Epistemic Humility: Accruing Wisdom or Forsaking Standards?" *Philosophy, Psychiatry, & Psychology: PPP* 29 (2): 101–6.
Weber, Valentin, and Dévan Rajendran. 2018. "UK Trained Osteopaths' Relationship to Evidence Based Practice - An Analysis of Influencing Factors." *International Journal of Osteopathic Medicine: IJOM* 29 (September): 15–25.
Wyatt, Katrina, Vanessa Edwards, Linda Franck, Nicky Britten, Siobhan Creanor, Andrew Maddick, and Stuart Logan. 2011. "Cranial Osteopathy for Children with Cerebral Palsy: A Randomised Controlled Trial." *Archives of Disease in Childhood* 96 (6): 505–12.